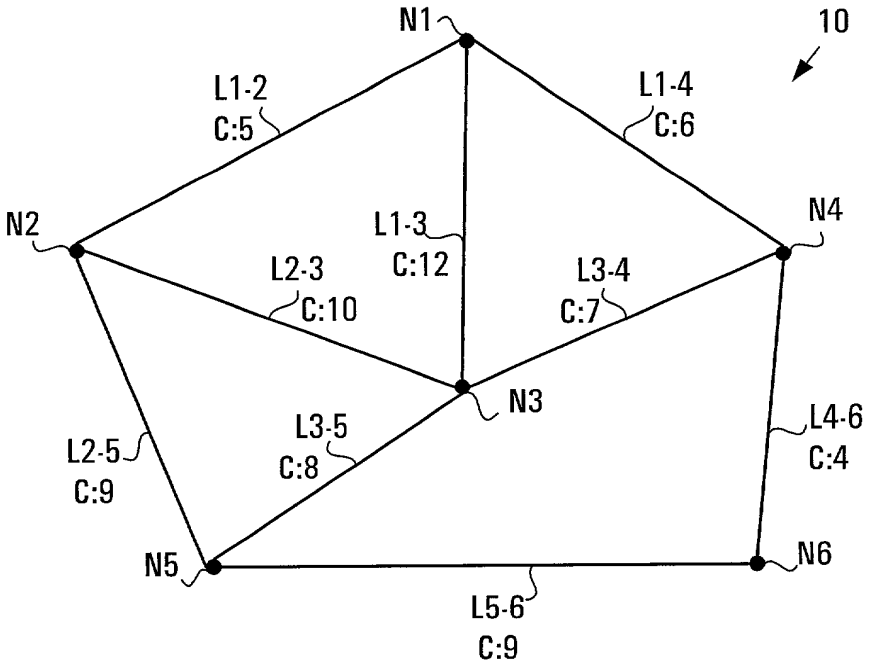
N1
10
L1-2
C:5
L1-4
C:6
N2
L1-3
C:12
N4
L2-3
C:10
L3-4
C:7
N3
L3-5
C:8
L4-6
C:4
L2-5
C:9
N5
N6
L5-6
C:9

FIG. 1

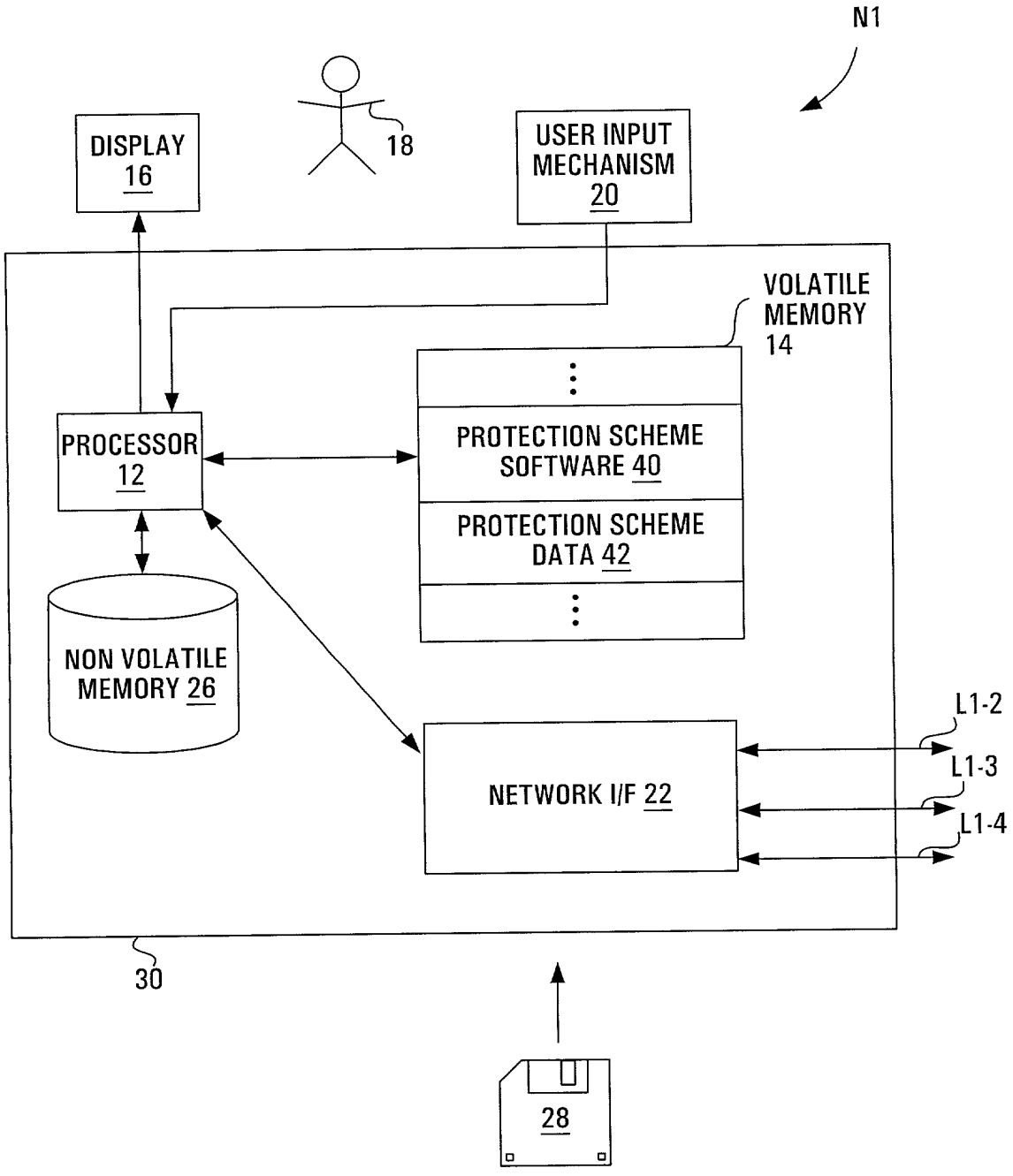
N1
DISPLAY 16
18
USER INPUT MECHANISM 20
VOLATILE MEMORY 14
PROCESSOR 12
PROTECTION SCHEME SOFTWARE 40
PROTECTION SCHEME DATA 42
NON VOLATILE MEMORY 26
NETWORK I/F 22
L1-2
L1-3
L1-4
30
28

FIG. 2

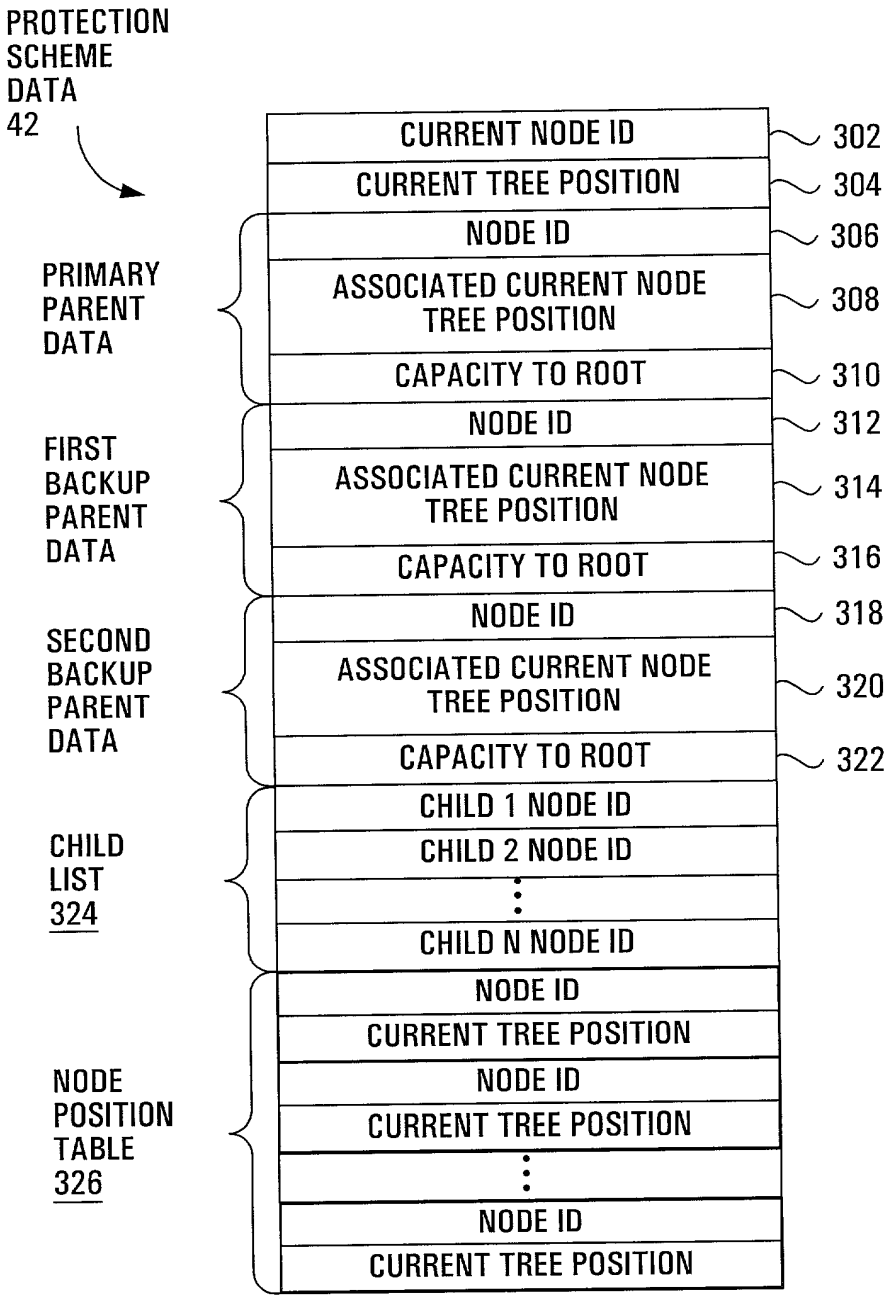
PROTECTION SCHEME DATA 42
CURRENT NODE ID
302
CURRENT TREE POSITION
304
PRIMARY PARENT DATA
NODE ID
306
ASSOCIATED CURRENT NODE TREE POSITION
308
CAPACITY TO ROOT
310
FIRST BACKUP PARENT DATA
NODE ID
312
ASSOCIATED CURRENT NODE TREE POSITION
314
CAPACITY TO ROOT
316
SECOND BACKUP PARENT DATA
NODE ID
318
ASSOCIATED CURRENT NODE TREE POSITION
320
CAPACITY TO ROOT
322
CHILD LIST 324
CHILD 1 NODE ID
CHILD 2 NODE ID
CHILD N NODE ID
NODE POSITION TABLE 326
NODE ID
CURRENT TREE POSITION
NODE ID
CURRENT TREE POSITION
NODE ID
CURRENT TREE POSITION

FIG. 3

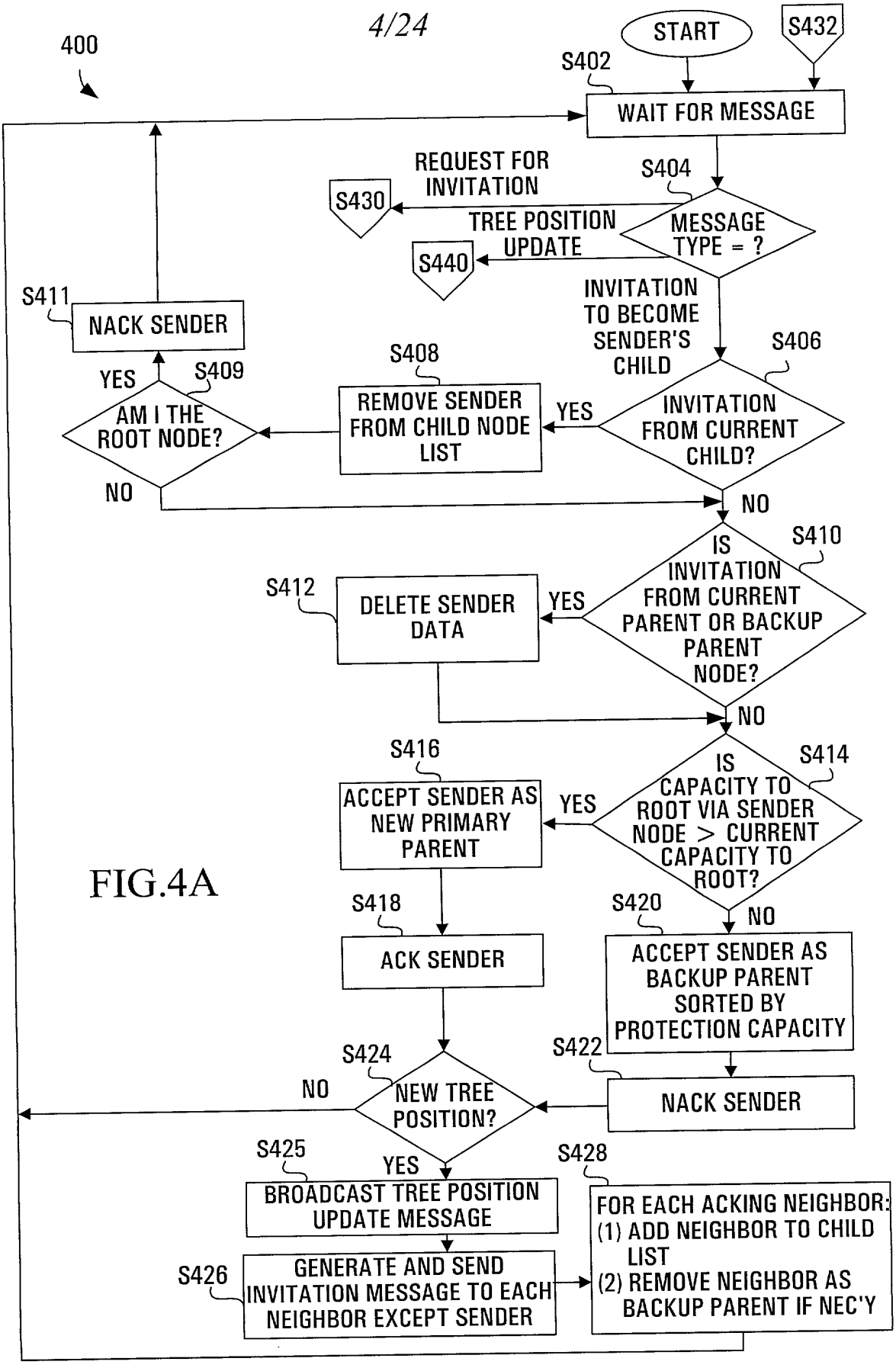
400
START
S432
S402
WAIT FOR MESSAGE
S404
REQUEST FOR INVITATION
S430
TREE POSITION UPDATE
S440
MESSAGE TYPE = ?
INVITATION TO BECOME SENDER'S CHILD
S406
INVITATION FROM CURRENT CHILD?
YES
S408
REMOVE SENDER FROM CHILD NODE LIST
S409
AM I THE ROOT NODE?
YES
S411
NACK SENDER
NO
NO
S410
IS INVITATION FROM CURRENT PARENT OR BACKUP PARENT NODE?
YES
S412
DELETE SENDER DATA
NO
S414
IS CAPACITY TO ROOT VIA SENDER NODE > CURRENT CAPACITY TO ROOT?
YES
S416
ACCEPT SENDER AS NEW PRIMARY PARENT
NO
S420
ACCEPT SENDER AS BACKUP PARENT SORTED BY PROTECTION CAPACITY
S418
ACK SENDER
S422
NACK SENDER
S424
NEW TREE POSITION?
NO
YES
S425
BROADCAST TREE POSITION UPDATE MESSAGE
S428
FOR EACH ACKING NEIGHBOR:
(1) ADD NEIGHBOR TO CHILD LIST
(2) REMOVE NEIGHBOR AS BACKUP PARENT IF NEC'Y
S426
GENERATE AND SEND INVITATION MESSAGE TO EACH NEIGHBOR EXCEPT SENDER

FIG.4A

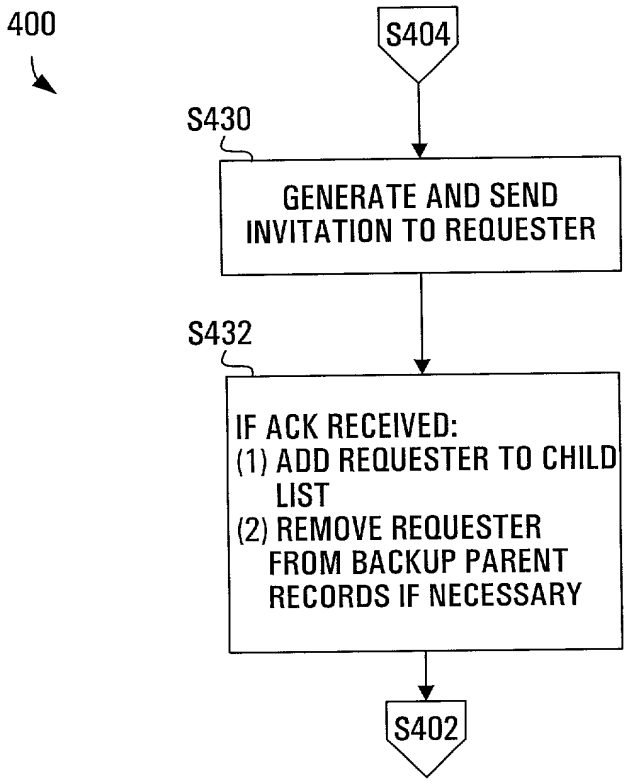
400
S404
S430
GENERATE AND SEND INVITATION TO REQUESTER
S432
IF ACK RECEIVED:
(1) ADD REQUESTER TO CHILD LIST
(2) REMOVE REQUESTER FROM BACKUP PARENT RECORDS IF NECESSARY
S402

FIG.4B

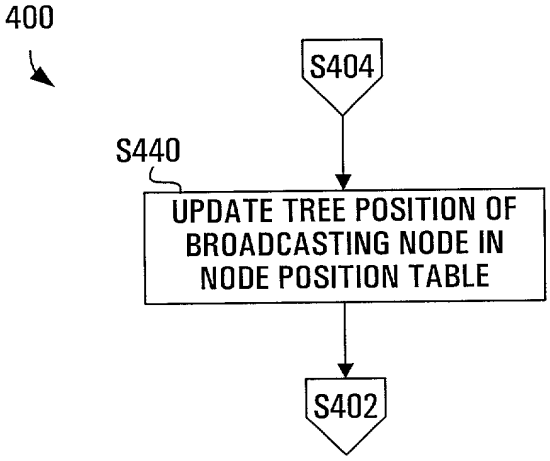
400
S404
S440
UPDATE TREE POSITION OF BROADCASTING NODE IN NODE POSITION TABLE
S402

FIG.4C

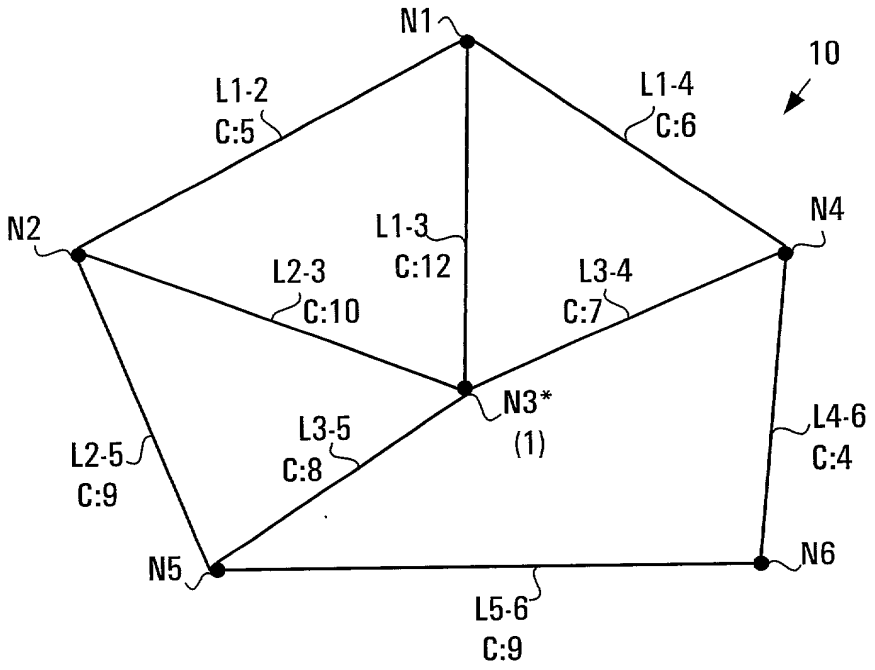
N1
10
L1-2
C:5
L1-4
C:6
N2
L1-3
C:12
N4
L2-3
C:10
L3-4
C:7
N3*
(1)
L4-6
C:4
L3-5
C:8
L2-5
C:9
N5
N6
L5-6
C:9

FIG.5A

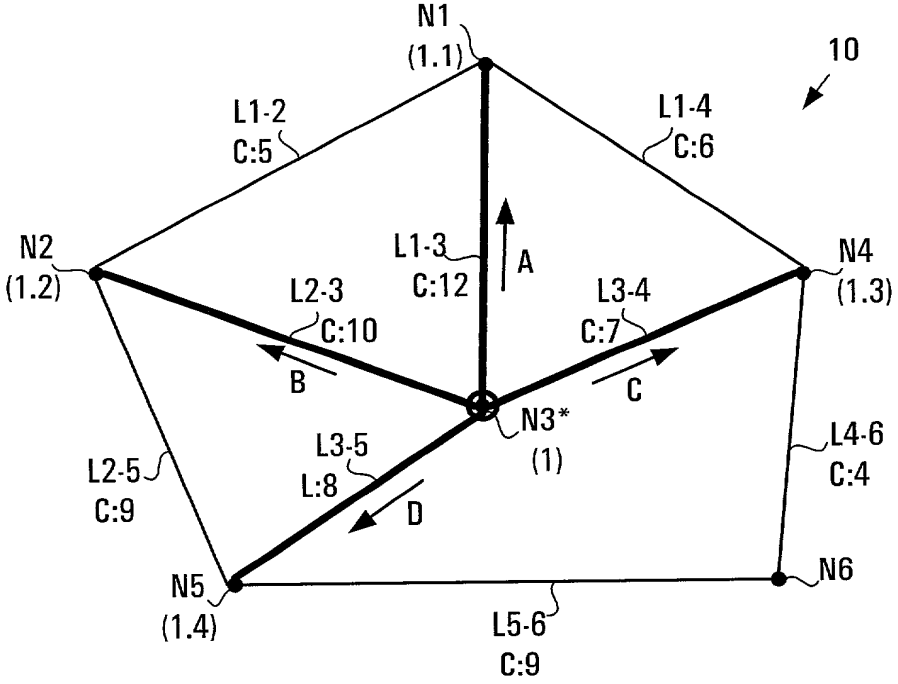
N1
(1.1)
10
L1-2
C:5
L1-4
C:6
N2
(1.2)
L1-3
C:12
A
N4
(1.3)
L2-3
C:10
L3-4
C:7
B
C
N3*
(1)
L4-6
C:4
L3-5
L:8
L2-5
C:9
D
N5
(1.4)
N6
L5-6
C:9

FIG.5B

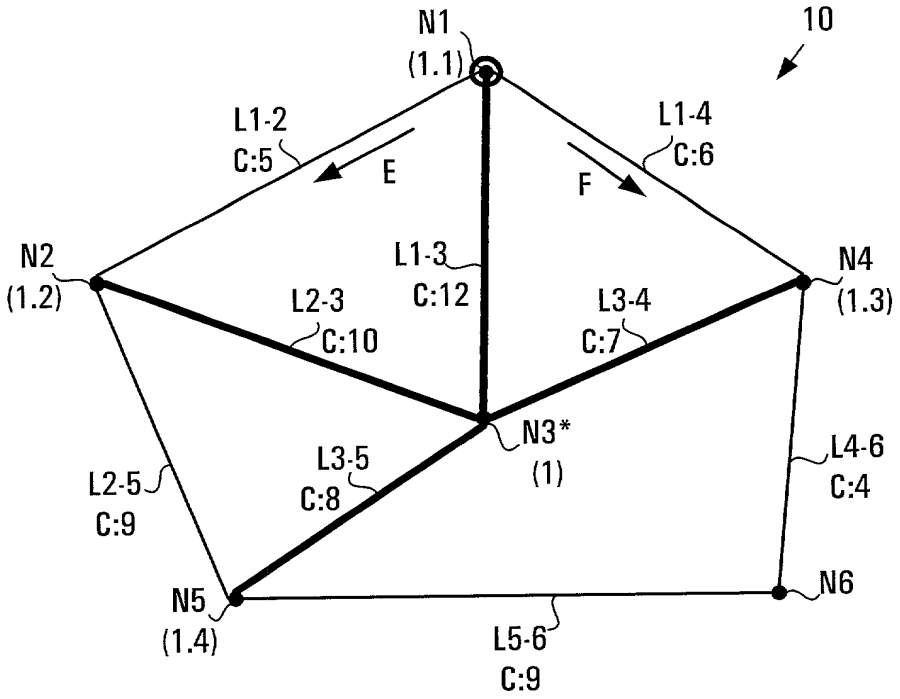
N1
(1.1)
10
L1-2
C:5
E
L1-4
C:6
F
N2
(1.2)
L1-3
C:12
N4
(1.3)
L2-3
C:10
L3-4
C:7
N3*
(1)
L4-6
C:4
L3-5
C:8
L2-5
C:9
N5
(1.4)
N6
L5-6
C:9

FIG.5C

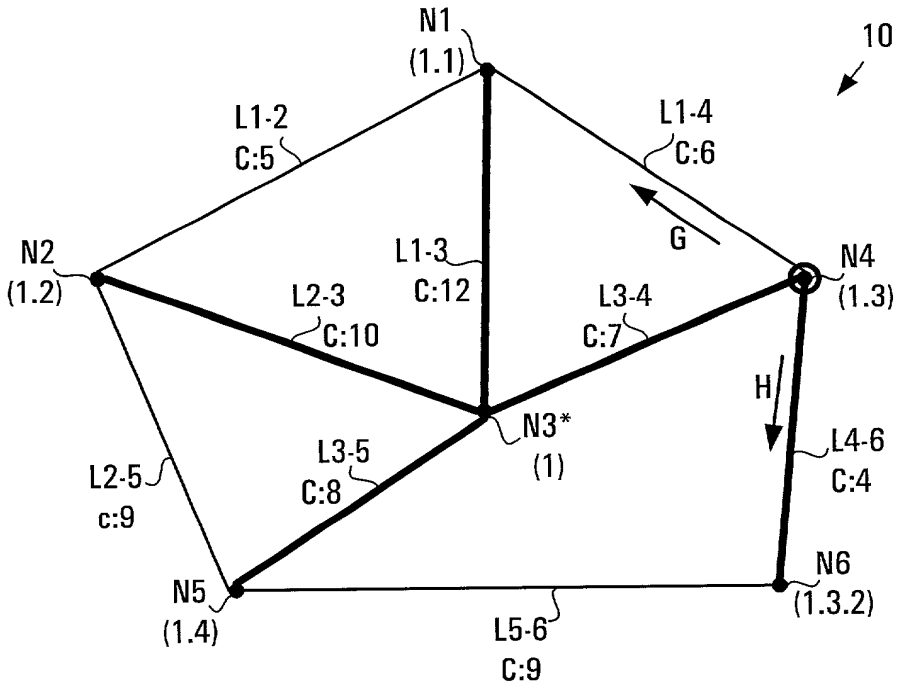
N1
(1.1)
10
L1-2
C:5
L1-4
C:6
G
N2
(1.2)
L1-3
C:12
N4
(1.3)
L2-3
C:10
L3-4
C:7
H
N3*
(1)
L4-6
C:4
L3-5
C:8
L2-5
c:9
N6
(1.3.2)
N5
(1.4)
L5-6
C:9

FIG.5D

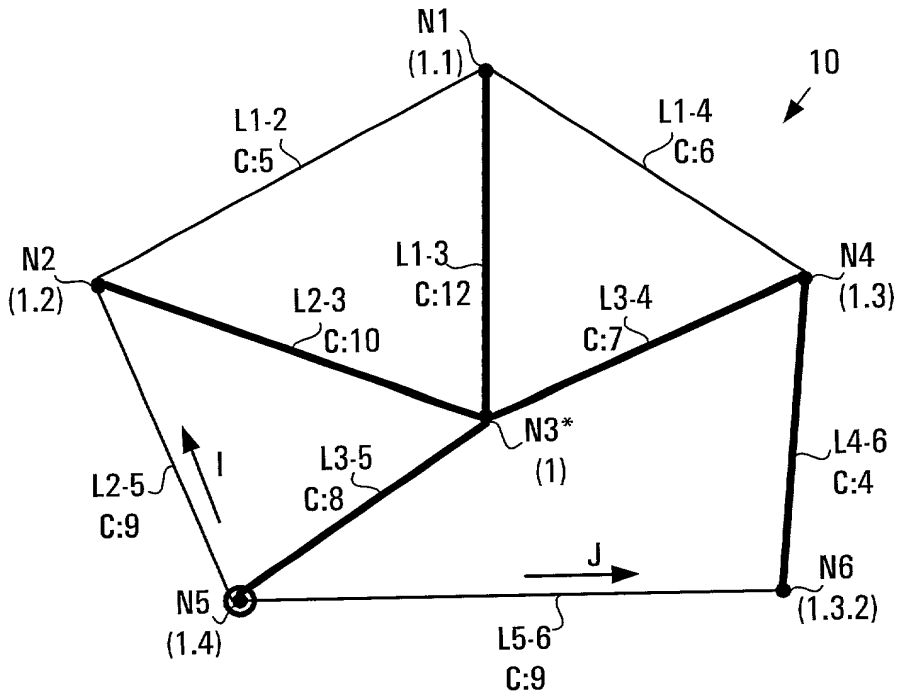
N1
(1.1)
10
L1-2
C:5
L1-4
C:6
N2
(1.2)
L1-3
C:12
N4
(1.3)
L2-3
C:10
L3-4
C:7
N3*
(1)
L4-6
C:4
I
L3-5
C:8
L2-5
C:9
J
N6
(1.3.2)
N5
(1.4)
L5-6
C:9

FIG.5E

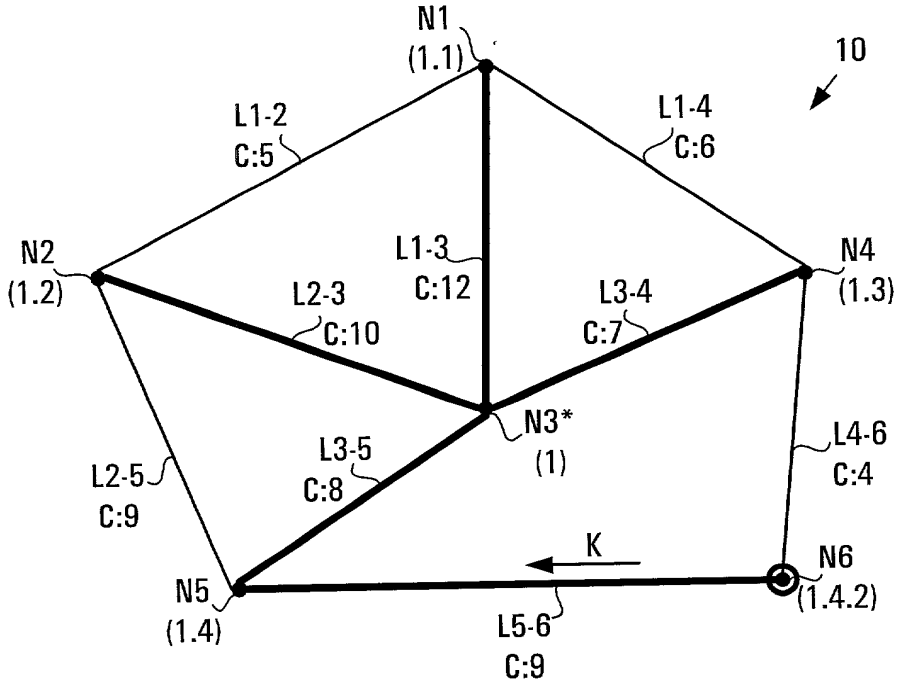
N1
(1.1)
10
L1-2
C:5
L1-4
C:6
N2
(1.2)
L1-3
C:12
N4
(1.3)
L2-3
C:10
L3-4
C:7
N3*
(1)
L4-6
C:4
L3-5
C:8
L2-5
C:9
K
N6
(1.4.2)
N5
(1.4)
L5-6
C:9

FIG.5F

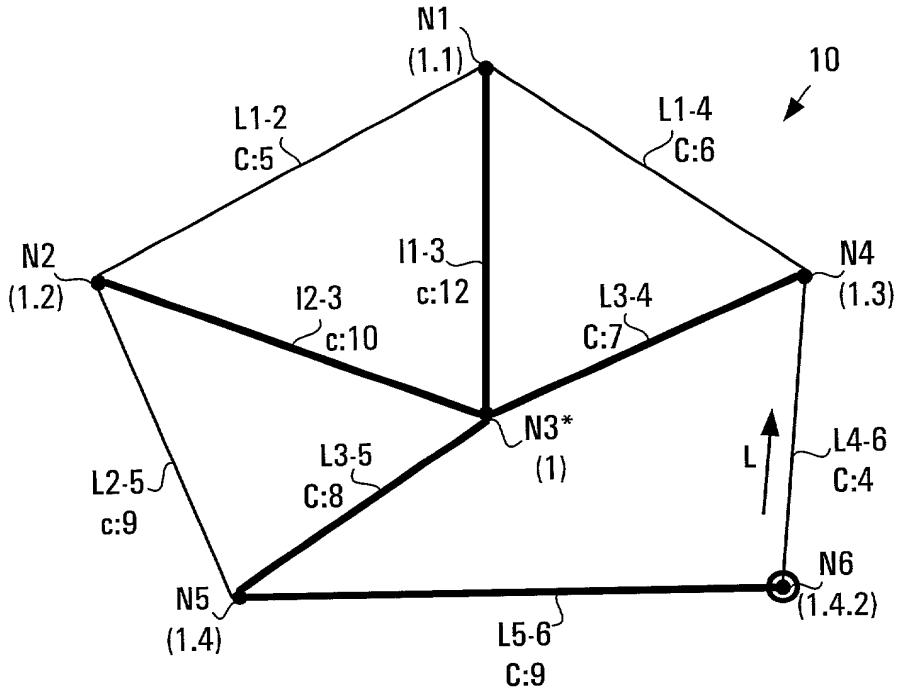
N1
(1.1)
10
L1-2
C:5
L1-4
C:6
N2
(1.2)
I1-3
c:12
N4
(1.3)
I2-3
c:10
L3-4
C:7
N3*
(1)
L
L4-6
C:4
L3-5
C:8
L2-5
c:9
N6
(1.4.2)
N5
(1.4)
L5-6
C:9

FIG.5G

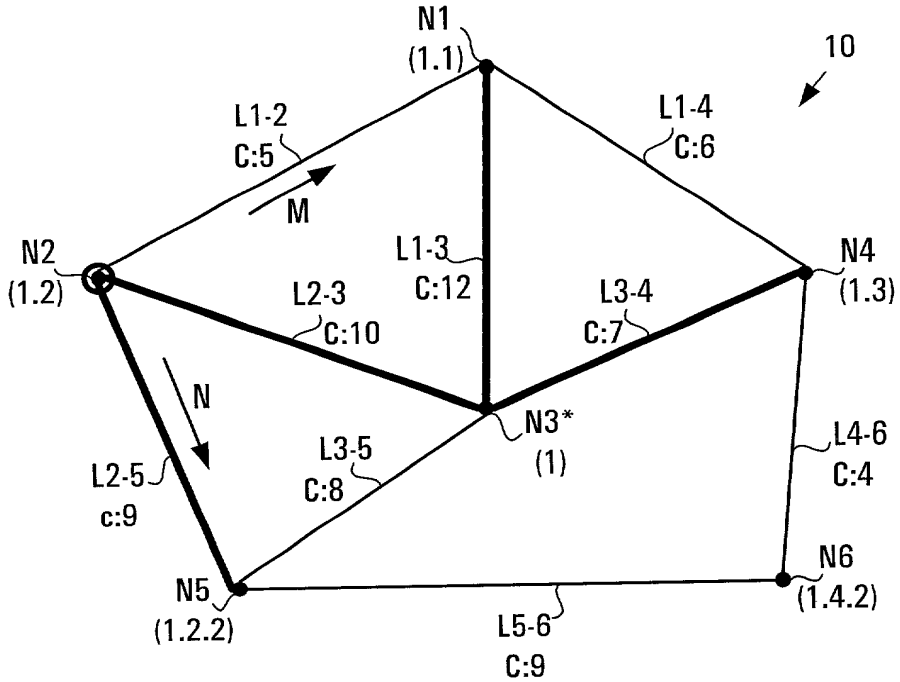
N1
(1.1)
10
L1-2
C:5
L1-4
C:6
M
N2
(1.2)
L1-3
C:12
N4
(1.3)
L2-3
C:10
L3-4
C:7
N
N3*
(1)
L4-6
C:4
L3-5
C:8
L2-5
c:9
N6
(1.4.2)
N5
(1.2.2)
L5-6
C:9

FIG.5H

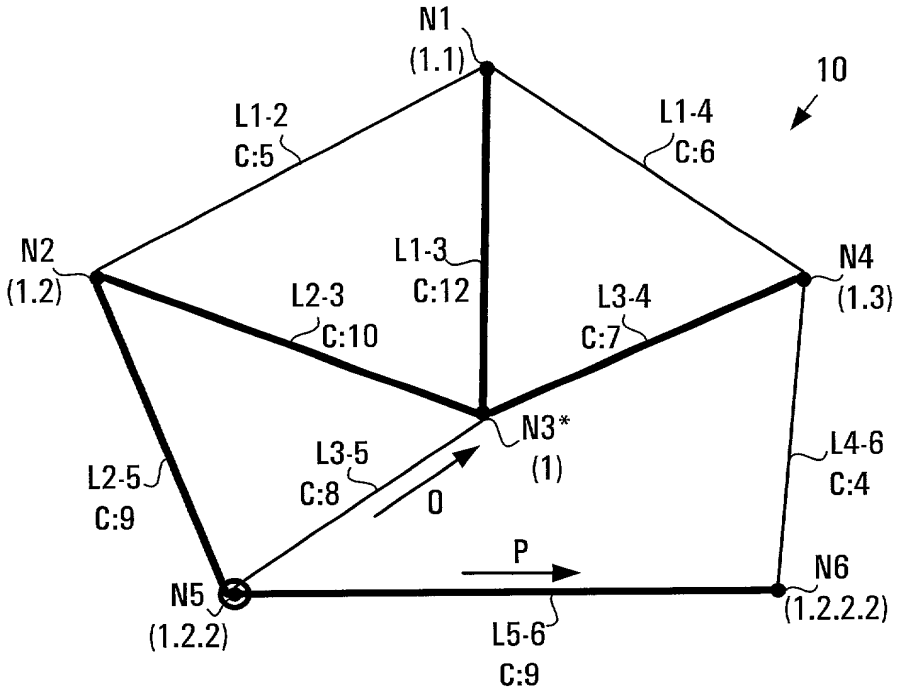
N1
(1.1)
10
L1-2
C:5
L1-4
C:6
N2
(1.2)
L1-3
C:12
N4
(1.3)
L2-3
C:10
L3-4
C:7
N3*
(1)
L4-6
C:4
L3-5
C:8
L2-5
C:9
O
P
N6
(1.2.2.2)
N5
(1.2.2)
L5-6
C:9

FIG. 5I

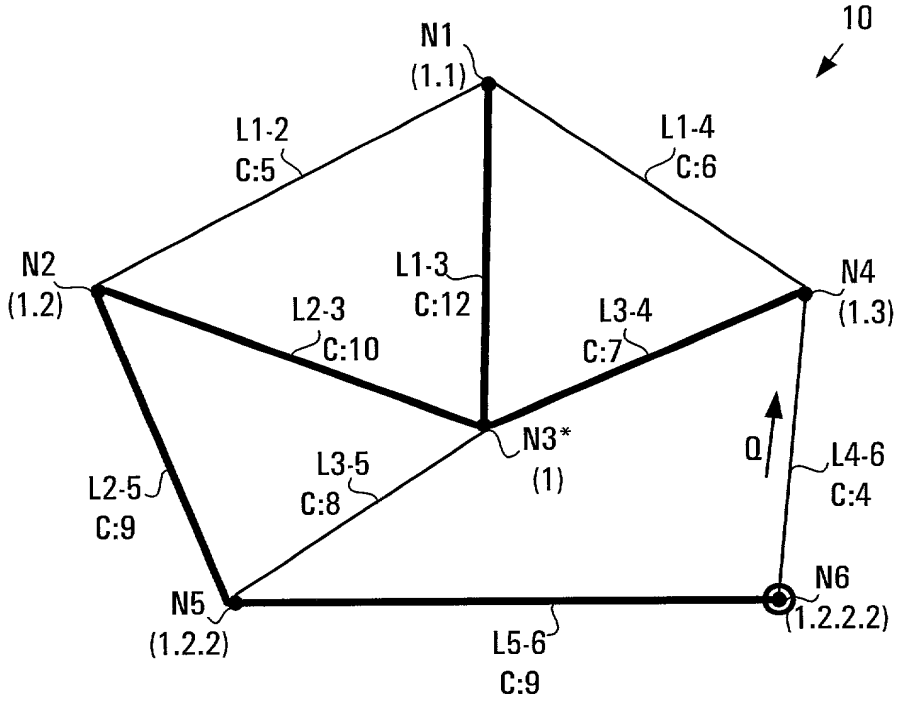
10
N1
(1.1)
L1-2
C:5
L1-4
C:6
N2
(1.2)
L1-3
C:12
N4
(1.3)
L2-3
C:10
L3-4
C:7
N3*
(1)
Q
L4-6
C:4
L3-5
C:8
L2-5
C:9
N6
(1.2.2.2)
N5
(1.2.2)
L5-6
C:9

FIG. 5J

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root
1	N1	-			0						
2	N2	-			0						
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-			0						
5	N5	-			0						
6	N6	-			0						

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2					
3	N3*					
4	N4					
5	N5					
6	N6					

610

FIG. 6A

	a	b	c	d	e	f	g	h	i	j	k
	node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	tree position	capacity to root node (max)	node ID	tree position	capacity to root node (max)	node ID	tree position	capacity to root node (max)
1	N1	-	**N3**	**1.1**	**12**						
2	N2	-	**N3**	**1.2**	**10**						
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	**N3**	**1.3**	**7**						
5	N5	-	**N3**	**1.4**	**8**						
6	N6	-			0						

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2					
3	N3*	**N1**	**N2**	**N4**	**N5**	
4	N4					
5	N5					
6	N6					

610

FIG. 6B

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root
1	N1	-	N3	1.1	12						
2	N2	-	N3	1.2	10	**N1**	**1.1.1**	**5**			
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	**N1**	**1.1.2**	**6**			
5	N5	-	N3	1.4	8						
6	N6	-			0						

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2					
3	N3*	N1	N2	N4	N5	
4	N4					
5	N5					
6	N6					

610

FIG. 6C

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root
1	N1	-	N3	1.1	12	**N4**	**1.3.1**	**6**			
2	N2	-	N3	1.2	10	N1	1.1.1	5			
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	N1	1.1.2	6			
5	N5	-	N3	1.4	8						
6	N6	-	**N4**	**1.3.2**	**4**						

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2					
3	N3*	N1	N2	N4	N5	
4	N4	**N6**				
5	N5					
6	N6					

610

FIG. 6D

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root
1	N1	-	N3	1.1	12	N4	1.3.1	6			
2	N2	-	N3	1.2	10	**N5** ~~N1~~	**1.4.1** ~~1.1.1~~	**8** ~~5~~	N1	1.1.1	5
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	N1	1.1.2	6			
5	N5	-	N3	1.4	8						
6	N6	-	N4	1.3.2	4						

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2					
3	N3*	N1	N2	N4	N5	
4	N4	N6				
5	N5					
6	N6					

610

FIG. 6E

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root
1	N1	-	N3	1.1	12	N4	1.3.1	6			
2	N2	-	N3	1.2	10	N5	1.4.1	8	N1	1.1.1	5
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	N1	1.1.2	6			
5	N5	-	N3	1.4	8	**N6**	**1.3.2.1**	**4**			
6	N6	-	**N5** ~~N4~~	**1.4.2** ~~1.3.2~~	**8** ~~4~~	N4	1.3.2	4			

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2					
3	N3*	N1	N2	N4	N5	
4	N4	N6				
5	N5	**N6**				
6	N6					

610

FIG. 6F

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root
1	N1	-	N3	1.1	12	N4	1.3.1	6			
2	N2	-	N3	1.2	10	N5	1.4.1	8	N1	1.1.1	5
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	N1	1.1.2	6	**N6**	**1.4.2.1**	**4**
5	N5	-	N3	1.4	8						
6	N6	-	N5	1.4.2	8	N4	1.3.2	4			

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2					
3	N3*	N1	N2	N4	N5	
4	N4	**N6**				
5	N5	N6				
6	N6					

610

FIG. 6G

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information: parent node: node ID	parent node: associated current node tree position	parent node: capacity to root	first backup parent node: node ID	first backup parent node: associated current node tree position	first backup parent node: capacity to root	~~second backup parent node~~: node ID	~~second backup parent node~~: associated current node tree position	~~second backup parent node~~: capacity to root
1	N1	-	N3	1.1	12	N4	1.3.1	6	**N2**	**1.2.1**	**5**
2	N2	-	N3	1.2	10	**N1** ~~N5~~	**1.1.1** ~~1.4.1~~	**5** ~~8~~	N1	1.1.1	5
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	N1	1.1.2	6	N6	1.4.2	4
5	N5	-	**N2** ~~N3~~	**1.2.2** ~~1.4~~	**9** ~~8~~	N3	1.4	8			
6	N6	-	N5	1.4.2	8	N4	1.3.2	4			

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2	**N5**				
3	N3*	N1	N2	N4	N5	
4	N4					
5	N5	N6				
6	N6					

610

FIG. 6H

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root
1	N1	-	N3	1.1	12	N4	1.3.1	6	N2	1.2.1	5
2	N2	-	N3	1.2	10	N1	1.1.1	5			
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	N1	1.1.2	6	N6	1.4.2	4
5	N5	-	N2	1.2.2	9	N3	1.4	8			
6	N6	-	**N5** ~~N5~~ ~~N5~~	**1.2.2.2** ~~1.3.2~~ ~~1.4.2~~	**8** ~~4~~ ~~8~~	N4	1.3.2	4			

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2	N5				
3	N3*	N1	N2	N4	**N5**	
4	N4					
5	N5	**N6**				
6	N6					

610

FIG. 6I

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information: parent node: node ID	parent node: associated current node tree position	parent node: capacity to root	first backup parent node: node ID	first backup parent node: associated current node tree position	first backup parent node: capacity to root	second backup parent node: node ID	second backup parent node: associated current node tree position	second backup parent node: capacity to root
1	N1	-	N3	1.1	12	N4	1.3.1	6	N2	1.2.1	5
2	N2	-	N3	1.2	10	N1	1.1.1	5			
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	N1	1.1.2	6	**N6** ~~N6~~	**1.2.2.2.1** ~~1.4.2~~	**4** ~~4~~
5	N5	-	N2	1.2.2	9	N3	1.4	8			
6	N6	-	N5	1.2.2.2	8	N4	1.3.2	4			

600

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2	N5				
3	N3*	N1	N2	N4		
4	N4					
5	N5	N6				
6	N6					

610

FIG. 6J

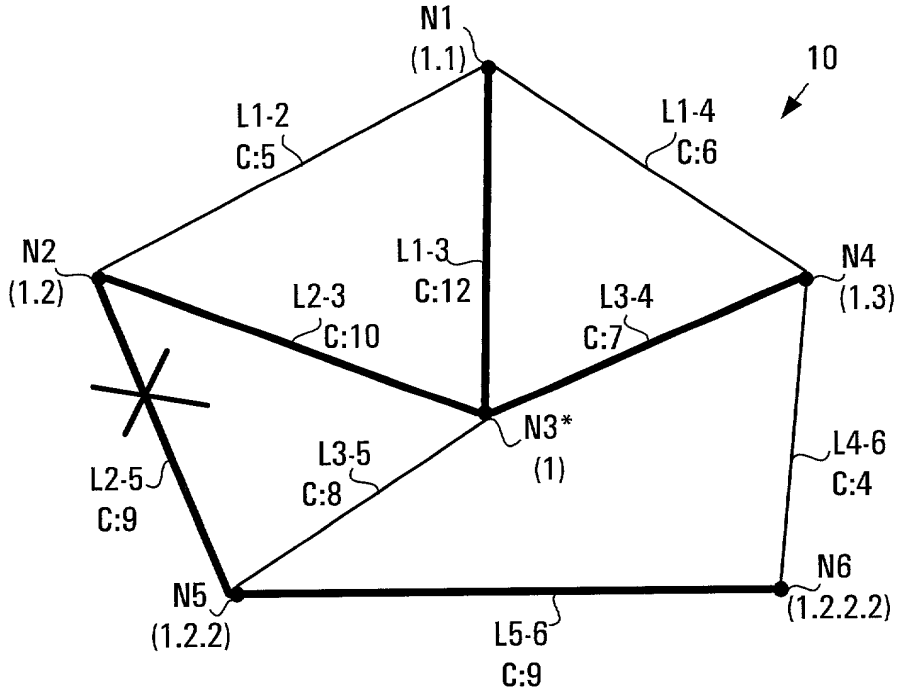
N1
(1.1)
10
L1-2
C:5
L1-4
C:6
N2
(1.2)
L1-3
C:12
N4
(1.3)
L2-3
C:10
L3-4
C:7
N3*
(1)
L4-6
C:4
L2-5
C:9
L3-5
C:8
N6
(1.2.2.2)
N5
(1.2.2)
L5-6
C:9

FIG.7A

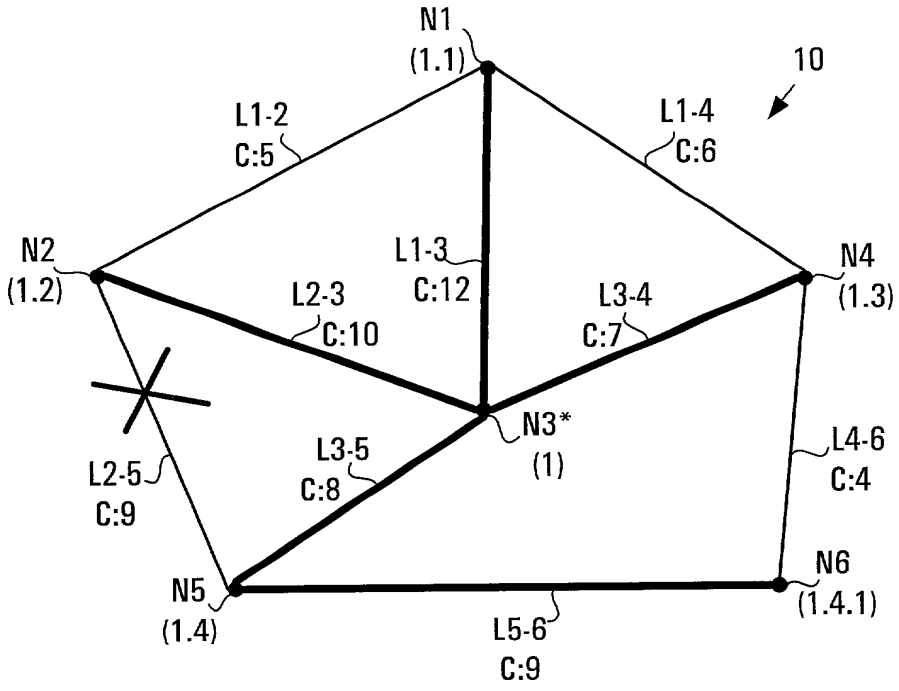
N1
(1.1)
10
L1-2
C:5
L1-4
C:6
N2
(1.2)
L1-3
C:12
N4
(1.3)
L2-3
C:10
L3-4
C:7
N3*
(1)
L4-6
C:4
L2-5
C:9
L3-5
C:8
N6
(1.4.1)
N5
(1.4)
L5-6
C:9

FIG.7B

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root
1	N1	-	N3	1.1	12	N4	1.3.1	6	N2	1.2.1	5
2	N2	-	N3	1.2	10	N1	1.1.1	5			
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	N1	1.1.2	6	**N6** ~~N6~~	**1.4.1** ~~1.2.2.2.1~~	**4** ~~4~~
5	N5	-	**N3** ~~N2~~	**1.4** ~~1.2.2~~	**8** ~~9~~	N3	1.4	8			
6	N6	-	**N5** ~~N4~~ ~~N5~~	**1.4.1** ~~1.3.2~~ ~~1.2.2.2~~	**8** ~~4~~ ~~8~~	N4	1.3.2	4			

800

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2	~~N5~~				
3	N3*	N1	N2	N4	**N5**	
4	N4					
5	N5	**N6**				
6	N6					

810

FIG. 8

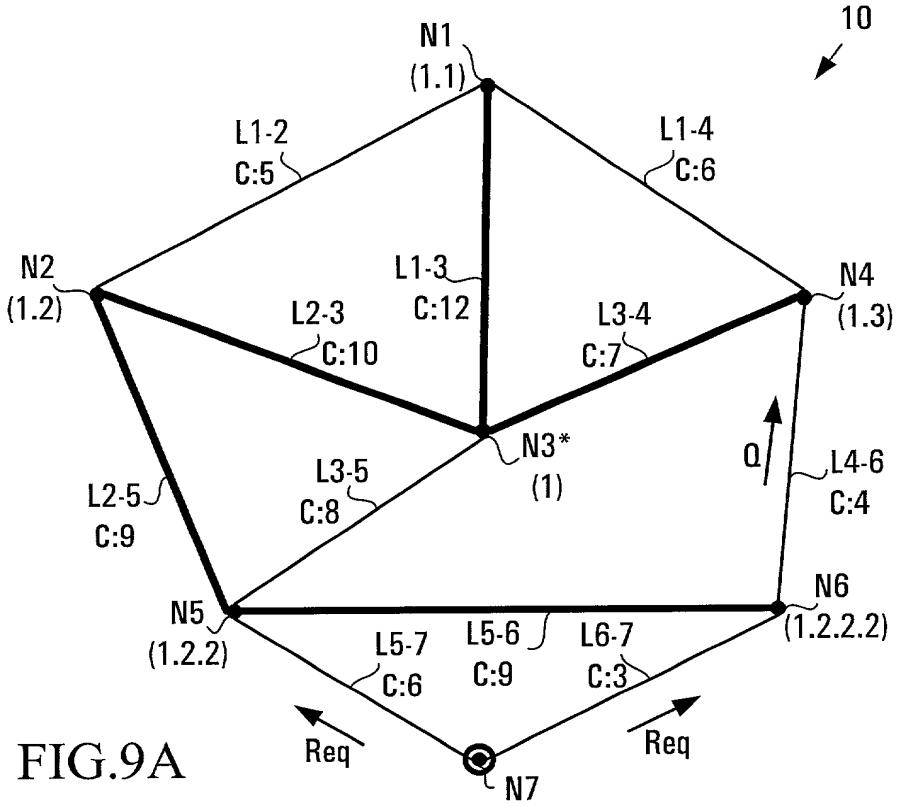

FIG.9A

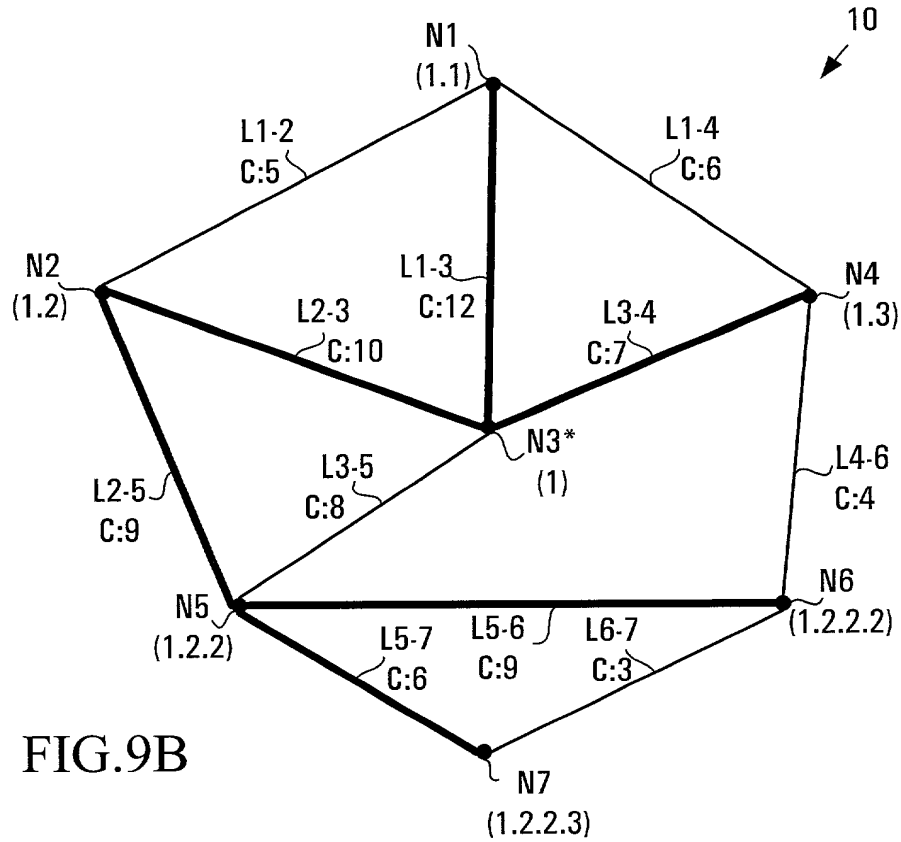

FIG.9B

Page 23 of 24 - 7/26/2004 1:06:26 PM

	a	b	c	d	e	f	g	h	i	j	k
	cur-rent node ID	current tree position	parent node information								
			parent node			first backup parent node			second backup parent node		
			node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root	node ID	associated current node tree position	capacity to root
1	N1	-	N3	1.1	12	N4	1.3.1	6	N2	1.2.1	5
2	N2	-	N3	1.2	10	N1	1.1.1	5			
3	N3*	1	-	-	-	-	-	-	-	-	-
4	N4	-	N3	1.3	7	N1	1.1.2	6	N6	1.2.2.2.1	4
5	N5	-	N2	1.2.2	9	N3	1.4	8			
6	N6	-	N5	1.2.2.2	8	N4	1.3.2	4	**N7**	**1.2.2.3**	**3**
7	**N7**	**-**	**N5**	**1.2.2.3**	**6**	**N6**	**1.2.2.2.2**	**3**			

1000

	a	b	c	d	e	f
	node ID	current children				
1	N1					
2	N2	N5				
3	N3*	N1	N2	N4		
4	N4					
5	N5	N6	**N7**			
6	N6					
7	**N7**					

1010

FIG. 10